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ABSTRACT

APPLYING SCIENTIFIC RESEARCH TO OPTIMIZE OPERATIONAL RATIONS – EXPLORING THE POSSIBILITIES by LTC Richard Proietto, USA, 46 pages.

Ever since the Army introduced its current primary operational ration, the Meals, Ready-to-Eat (MRE), in the early 1980's it has committed itself to continuously improving them. This has resulted in a far greater variety of menu items, and a taste that is more like what Americans are used to eating than Army Food. Unfortunately, these efforts to mirror the Standard American Diet have resulted in a nutrition program that resembles the less than optimal American diet. An American diet that is so bad, it caused the then Surgeon General C. Edward Koop in 1988 to declare that America's eating habits have contributed to the nation's most common killers such as coronary heart disease, stroke, atherosclerosis, diabetes, and some cancers. A diet that is also considered one of the worst in the developed world.

It is in this backdrop, that this monograph takes a critical look at the Army's MRE's, and compares their mix of the fuel nutrients (protein, carbohydrates, and fats) to what nutrition scientists believe to be the optimum mix. A mix that science has shown to enhance physical performance, and prevent a large number of diseases. A mix that, once incorporated into MRE's, will ultimately contribute to soldiers being able to sustain optimal effort, for any operation, no matter how long in duration.

The monograph concludes that the Army's primary operational ration is far from optimal because two of the fuel nutrients, fats and carbohydrates, are clearly not in the right quantities and mix in MRE's. Additionally, sodium levels in MRE's are way too high. Subsequently, this monograph recommends that the Army's Surgeon General's Office update their sixteen-year old nutrition directive (AR 40-25) to reflect advances made in nutrition science in the past two decades. The Army's Research and Development (R&D) community at the Soldier and Biological Chemical Command (SBCCOM) must then translate this directive into the right mix of nutrients to be included in MRE's, and ensure MRE manufacturers provide this "new" mix in all MRE's. Finally, the Army's R&D community must quit trying so hard to mirror the American diet, and never forget they are feeding warriors, not the "average" American. This will ensure that the war-fighting Commanders in Chief (CINC's) have at their disposal soldiers who not only have the finest equipment the science and technology communities have to offer, but also the best nutrition the nutrition science community has to offer.

Applying Scientific Research to Optimize Operational Rations – Exploring the Possibilities

A Monograph
by
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CHAPTER 1

INTRODUCTION

Why write a research paper on Army nutrition? What could possibly be wrong with the current combat rations being fed to soldiers? They provide calories and no soldier has ever gone hungry, or died from eating Army food. Knowing the importance food plays in disease prevention and physical performance, should not the Army already be providing its soldiers optimal nutrition, based on the latest research in nutrition, to allow them to be, as one Army slogans puts it, "Fit to Fight"? That is the question this monograph will explore, and if the Army is providing sub-optimal nutrition, make recommendations on how to make their current operational rations even better.

The purpose of this monograph, then, is to critically examine army nutrition, or, more simply put, army food. Why was this topic chosen, and how is it relevant? After all, is not the United States the best fed nation in the world, and, shouldn't that mean, therefore, that the U.S. Army is also equally well fed? Based on the latest research, the answer to both questions may not necessarily be yes. As a matter of fact, the American diet, which the Army's operational rations try to mirror, has been shown to cause a number of life-threatening diseases and is a major cause of America's weight gain epidemic. This has led, in turn, to a large number of conflicting best selling nutrition books, by so-called nutrition experts, all professing to have the solution to America's nutrition dilemma.

It is because of America's dismal nutritional showing, all the conflicting guidance on what to eat, and because the Army's primary operational ration, the Meal-Ready-to-Eat (MRE), is designed to mirror the American diet, that this monograph topic seemed worthy of a research project. The fact that a recent study by Marywood University's Dr. Lee Harrison published in the December 2000 issue of The American Journal of Health Promotion revealed that the

military has the same weight gain problems as the American public,[1] make this project all the more relevant. The approach taken will be to review current scientific literature on nutrition, and present only credible research based on the gold standard of double blind studies, or where considerable regulated observation has been made.

This monograph will explore how the U.S. Army can use the latest discoveries in the field of nutrition science to its advantage, to ensure its soldiers are receiving optimum nutrition. Optimum nutrition which science has shown will result in greater health, greater energy, greater mental acuity, and a better functioning immune system. The relevance of this topic, then, becomes self evident, as the Army should embrace any way that it can enhance the capability of its most valuable asset – the individual soldier.

More importantly, for the war-fighting Commanders-in-Chief (CINC's) it will mean they will receive soldiers that not only have the best equipment the science and technology communities have to offer, but also the best rations the nutrition science community has to offer. With optimum nutrition, these soldiers will be able to fight longer, harder, and with greater resistance to disease. This should give the CINC's confidence that their soldiers can perform under the most physically demanding conditions, and can do it for the long haul. This last point is important, as America's Army has not had to endure combat for any great length since the Vietnam conflict, and it is under these long-duration conflicts that the Army will undoubtedly feel the effects of optimum nutrition. An additional benefit for the Department of the Army and the Department of Department of Defense, would be a possible reduction in health care costs over the long run.

Nutrition, then, is a vital element in the Army's efforts to field the healthiest, fittest soldiers it possibly can. It becomes even more important when one factors in the unique nutrition requirements of soldiers inherent in their profession. In a combat or field environment, it is not

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[1] Steve Blechman and Thomas Fahey, Ph.D. "Fitness Research," Muscular Development, April 2001, 35.

uncommon for these soldiers to work long hours, often sleep deprived, under the most arduous, stressful of conditions. These are all conditions that require the right mix of fuel nutrients to ensure soldiers are able to perform at optimum levels for long periods of time.

Soldiers are also expected to exert themselves physically, for extended periods, both areobically and anaerobically. Interestingly, this type of physical exertion is not unlike what an athlete training for a sport that stresses both strength and endurance would be expected to accomplish. Not surprisingly, since nutrition plays such a major role in the success or failure of both professional and amateur athletes, extensive scientific research has been conducted to determine the optimum nutrition for athletes. The findings from this research, therefore, will be considered in this monograph to determine what would work best for soldiers.

At this point, it is probably a good idea to describe what exactly "Optimum Nutrition" is. Optimum nutrition, according to world renowned nutrition scientist, Dr. Michael Colgan, is a relatively narrow range where nutrient intake results in 100% biological function.[2] This is the point at which physical performance is optimized. Anything more or less than optimum nutrient intake levels, will result first in sub-optimal biological function, and then, if taken to extremes, death. This is because too much nutrient intake becomes progressively toxic, and too little will result in progressive deficiency.

The key then in determining if soldiers are receiving optimum nutrition is, therefore, to determine if Army operational rations provide the right mix of nutrients that put them in the optimum range, ensuring that the individual soldier's biological function is at or near 100 percent. If this is found not to be the case, it will determine what the Army Research and Development (R&D) community must do to reach that point. To limit the scope, the focus of this paper will be primarily on the macronutrients referred to as the fuel nutrients: protein, carbohydrates, and fat. So called because these are the only nutrients that can be used to provide energy for the body's

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[2] Michael Colgan, Ph.D., Optimum Sports Nutrition (Ronkonkama, N.Y.: Advanced Research Press, 1993), 15.

working tissues.[3] They are also the only nutrients that provide calories to the body. They are, in essence, the workhorse nutrients that provide fuel to the body - the ones whose mix contributes greatly to optimum nutrition. It is, therefore, imperative that all three remain within optimal levels, as determined by the scientific community, for if any one is not, than the end result will be sub-optimal nutrition. Additionally, they are the nutrients that are the root cause of America's current "Nutrition Debate." It is for these reasons that they will be the primary focus of this paper, along with, to a lesser degree, several other widely researched nutrients which the Army may find of value.

[3] Encyclopedia of Sports Science "Nutrition and the Athlete," (New York, N.Y.: Simon and Schuster Macmillan, 1997), 722.

CHAPTER 2

NUTRITION IN U.S. SOCIETY AND THE ARMY

NUTRITION SCIENCE – A HISTORICAL PERSPECTIVE

No research paper on nutrition science would be complete without a brief overview of its history, and a description of how nutrition guidelines and policy are made in the U.S. While it is only recently that food has begun to receive attention from historians, it has always been a central concern for anthropologists.[4] From what little written evidence their exits of the importance of food in good health, it appears the people of the Mediterranean basin and the Far East were the first to truly recognize and document the critical role of food in disease prevention, and for maintaining health.

In ancient Greece around 400 B.C., for instance, Hippocrates the father of modern Western medicine, recognized that the science of nutrition was vital to good health. He went as far as stating to men of medicine that they should, "Leave their drugs in the chemist's pot if they can heal the patient with food".[5] In fact, he was so strongly convinced of the power of food to prevent disease that he wrote a book entitled On Diet where he talks about the critical role diet plays in good health.[6] He even went as far as to decree that food should be considered in the same light as medicine.[7] He was convinced, without the benefit of scientific studies or modern laboratories, that nutrition improved the body's immune function to help ward off disease, and could be used to help patients recover from illness. Apparently, he may have been on to something back then, as he apparently lived into his 90's.

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[4] "Food and Drink in Ancient Mediterranean," The University of Warwick, Online.
[5] James F. Balch, M.D. and Phyllis A. Balch, Prescription for Dietary Wellness (Garden City Park, N.Y.: Avery Publishing Group, 1998), 1.
[6] "Hippocrates," Microsoft Encarta, Online.
[7] Daniel Reid, The Complete Book of Chinese Health & Healing (Boston, Mass.: Shambhala Publications, Inc., 1995), 100.

Interestingly, about the same era, in a completely different part of the world, similar ideas about nutrition were being expounded. In ancient China, men of medicine recognized the importance of proper nutrition in keeping good health and preventing illness. Their medical texts, and in particular the Internal Medicine Classic written in the third century B.C., touts the disease preventive benefits of proper nutrition.[8] Additionally, ancient Chinese medicine, which eventually came to be known as Traditional Chinese Medicine (TCM), also addresses the therapeutic properties it believes are found in certain herbs. Although, these herbs have been used effectively for centuries to help prevent or cure certain illnesses, most medical schools in the U.S. do not teach classes on the benefits of herbs.[9] This is probably due to the fact that very few of these herbs have been studied thoroughly, or not at all, which, quite frankly, is surprising since it is well known that several of the most potent modern medicines are derivatives of plants in the Rain Forests of South America.

Modern American medicine, by contrast, has been slow to heed the advice of the ancient Greeks and Chinese in regards to food. In fact, it wasn't until 1988 that, for the first time in US history, the Surgeon General, C. Everett Koop, acknowledged the value of a good diet, while simultaneously condemning typical eating patterns.[10] According to his statement, fully two-thirds of all deaths are directly affected by improper diet, and poor eating habits play a large part in the nations most common killers – coronary heart disease, stroke, atherosclerosis, diabetes, and some cancers. What is even more startling is the fact that the average American physician knows very little about nutrition in general.[11]

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[8] Ibid.
[9] Stephen T. Sinatra, M.D., Optimum Health (New York, N.Y.: Lincoln-Bradley Publishing Group, 1996), 127.
[10] Paul Pitchford, Healing with Whole Foods (Berkely, California: North Atlantic Books, 1993), 1.
[11] Kevin Vigilante, MD and Mary Flynn, PhD., Low-Fat Lies High-Fat Frauds (Washington, DC: LifeLine Press, 1999), 20.

As far as nutrition science being a formal, recognized field of study, that really didn't happen in the United States until 1934, when the American Institute of Nutrition was founded.[12] Since then, a number of outstanding nutrition science programs have appeared throughout American academia. Schools such as the Department of Nutrition at the Harvard School of Public Health and the School of Nutrition Science and Policy at Tufts University, to name just a few, have become some of the most preeminent nutrition schools in the world. It is from schools such as these, that most of the cutting-edge research on nutrition is being done.

NUTRITION POLICY MAKERS IN THE U.S.

Now exactly how and who establishes nutrition guidelines in the US? The answer to that question is not as apparent as it may at first seem. The United States Department of Agriculture (USDA) is the federal agency responsible for advising the American public on nutrition. They're the agency that provides a nutritional road map to good health, based on the latest scientific research. They do this in the form of the USDA Dietary Guidelines that they publish with the support of the Department of Health and Human Services (DHHS).[13] President Clinton officially unveiled the most recent edition of these guidelines on 30 May 2000 at the National Nutrition Summit. At the Summit, President Clinton stated that the 5th edition of the Dietary Guideline for Americans would "empower Americans with the latest information on food and nutrition."[14] As a derivative of this, is the USDA Food Guide Pyramid, which most people are probably familiar with. Together the Dietary Guidelines and the Food Guide Pyramid provide the American public with specific advice on healthy eating habits.

A major criticism of USDA is the speed at which they change their dietary advice in the face of scientific evidence that warrants it. An important case in point, has to do with how long they

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[12] Encyclopedia of Sports Medicine "Nutrition and the Athlete," (New York, N.Y.: Simon and Schuster, 1997), 720.
[13] Etta Sattos, Ph.D., "The Food Pyramid-Food Label Connection," USDA, Online, 1.
[14] This quote was found in the USDA's web site.

took to change the current Food Guide Pyramid from the previous four food group recommendation. It took pressure from various scientific and physicians group lobbies in 1991 to convince the USDA to abandon the Four Food Groups, and reclassify meats and dairy products as "optional foods."[15] One prominent voice, Dr. T. Colin Campbell, Professor of Nutritional Biochemistry at Cornell University, presented unequivocal evidence to the USDA, that current intakes of meat and dairy products in America are a major cause of our high rates of cancer, heart disease, diabetes, obesity, and osteoporosis.[16] Perhaps USDA's reluctance to make the change is understandable when considering the fact they are committed to assisting America's farmers and ranchers, and, therefore, whenever they make dietary decisions they must also consider the ramifications for those two groups.

Another key player in the establishment of nutrition guidelines is the Food and Nutrition Board of the National Academies of Science. The National Academies of Science is a private, non-profit corporation created by an act of Congress in 1863, which is chartered to advise the American people in science, engineering, and medicine. This organization is the one that publishes, under contract to the USDA and the DHHS, the Recommended Dietary Allowances (RDA) for essential macro and micronutrients. It is important to note here, that the USDA's RDA's are what the Army bases the development of their operational rations on. The Food and Nutrition Board has periodically updated the RDA, whenever new scientific data warranted it, in the form of a handbook entitled Recommended Dietary Allowances. The most recent edition of this handbook, the 10th, was published in 1989.

These RDA's, however, going back to the first one published in 1941, were only intended to prevent diseases caused by nutrient deficiencies in the majority of the population.[17] They were

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[15] Michael Colgan, PhD., The New Nutrition-Medicine for the Millennium (Vancouver, Canada: Apple Publishing, 1995), 4.
[16] Ibid,. 5.
[17] Sattos, "The Food Pyramid-Food Label Connection," 1.

never intended to provide optimum nutrition for the American population or for any single person for that matter. They were just designed to prevent diseases such as scurvy or beriberi.

Recognizing this shortcoming in the RDA's, the Food and Nutrition Board decided in 1993 that it was advisable to revise the RDA's to prevent diet-related chronic conditions such as heart disease, diabetes, hypertension, and osteoporosis.[18] The result of this decision, was to publish a completely new category called Dietary Reference Intakes (DRI) which is comprised of the RDA, the Estimated Average Requirement (EAR), the Adequate Intake (AI), and the Tolerable Upper Intake Limit (UL). The EAR being the amount of a nutrient that will meet the needs of 50% of healthy people based on strong research evidence, the AI being the amount of nutrient for those nutrients which have no established EAR because of lack of research evidence (these of course are not nearly as accurate as EAR), and the UL is simply the highest amount of a nutrient that can be safely consumed on a daily basis.[19] It is important to note here, that like the old RDA's, these new dietary categories were designed to meet the nutritional needs of the average sedentary American, they were never designed to meet the needs of special population groups such as athletes, firefighters, and, yes, soldiers.

In developing the DRI's, the Food and Nutrition Board has seven different panels each looking at different essential (those nutrients which the human body cannot produce) nutrients. The project is scheduled to be completed by the end of 2001.[20] To date about half the DRI's have been developed. For those nutrients that DRI's haven't been developed yet, the old RDA's found in the 1989 edition are still in effect.

Another major federal government player is the Food and Drug Administration (FDA), under the DHHS, which acts like a mutually supporting partner to the USDA when it comes to nutrition. They are, in fact, both funding the DRI project being conducted by the Food and Nutrition Board.

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[18] Ibid.
[19] Ibid., 2.
[20] "Scientific Evaluation of Dietary Reference Intakes," Food and Nutrition Board, Online.

The FDA's mission is to promote public health by ensuring food sold in the US is safe and wholesome.[21] They also regulate the multi-billion dollar dietary supplement industry, which is important to the military in the event they decide to incorporate dietary supplements in the soldiers' diet.

Of course, there are significant non-government organizations, in particular the American Heart Association (AHA) and the American Cancer Society, which make very valuable recommendations on nutrition. Since these organizations, in regards to nutrition, are focused on the prevention of disease, they are definitely key players in any discussion on optimum nutrition. For the most part, these organizations concur with the USDA's recommendations made in their latest edition of Dietary Guidelines for Americans. There are, however, a few minor differences that will be pointed out later in this paper.

Additionally, there are a number of sports nutritionists whose focus is solely on optimum nutrition to enhance athletic performance. Since soldiers are in a physically demanding profession, and at times extremely physically demanding, the latest research in the field of sports nutrition may have some relevance, and may be of some use in designing nutrition programs for the Army. In particular, nutrient combinations and nutritional supplements, backed up by scientific research, which have been used successfully on athletes, should be seriously considered.

In the Army, the major player in developing nutrition guidelines is the Army Surgeon General who is responsible, along with the Surgeon Generals of the other military services, to publish nutrition guidance and the Military Recommended Dietary Allowances (MRDA). They do this in a the form of a co-authored regulation entitled Nutrition Allowances, Standards, and Evaluation, which for Army personnel is Army Regulation (AR) 40-25, with the most current

[21] "Inside the Food and Drug Administration: An Overview," U.S. Food and Drug Administration, Online.

edition dated 15 May 1985.

The MRDA's contained in this AR were adapted from the NAS's 9th revised edition, published in 1980, of their Recommended Dietary Allowances handbook.[22] Which means, obviously, that the current AR is based on RDA's that were published nearly a decade before the most current ones were, and, in some cases, 20 years before the new RDA's that are part of the Food and Nutrition Board's new Dietary Recommended Intakes were. This, however, may not be that significant since some of the RDA's did not change, or did not change by much. Certainly, though, all differences should be considered in the evaluation of the Army's current nutrient mix.

It should also be noted that AR 40-25 specifically addresses operational rations, and in so doing established nutritional standards for them. The AR also directs that individual operational rations such as MRE's must be formulated so that the nutrient content of each day's ration satisfies these nutritional standards.[23] Additionally, it directs that each combat meal must provide one-third of the daily nutrient standard.[24] Put another way, a soldier has to eat three MRE's to get all the nutrients outlined in the nutritional standards.

ARMY OPERATIONAL RATIONS – MEALS, READY-TO-EAT

MRE's replaced the canned Meal, Combat Individual (C-Ration) as the Army's individual operational ration in the early 1980's. It was fielded at about the time the Army was transitioning into what was known as the Army of Excellence (AOE). During this period, under the AOE initiative, the Army almost completely modernized and reorganized its combat units. It is this AOE Army, which has come to be known as the "Legacy Force", which the CSA is in the process of transforming into the "Objective Force" to enable it to face the emerging threats of the 21st Century.

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[22] AR 40-25, Nutrition Allowances, Standards, and Education (Department of the Army, 15 May 1985), 2-1.
[23] Ibid.
[24] Ibid.

It probably should be pointed out here, that as the Army transforms itself into the Objective Force, MRE's will most likely play an even greater role in its Combat Feeding Program. This is due primarily to the fact that the Objective Force units are designed to sustain themselves longer than today's force can, and be able to perform independent operations of greater duration than is possible today. Which means units will have to rely more heavily on MRE's to feed their soldiers. For the individual soldier, it will most likely result in consuming even more MRE' than they are today.

MRE's are quite unique in that all the R&D conducted on them is done by the military. The reason for this is that the food industry has little profit incentive to conduct R&D aimed at meeting specific requirements of military operations. [25] The responsibility for developing MRE's rests entirely with the U.S. Army Soldier System Center, which is subordinate to the U.S. Army Soldier and Biological Chemical Command (SBCCOM), located at Natick, Mass. The development of MRE's falls under the Department of Defense (DOD) Combat Feeding Program (CFP), which is part of the Soldier System Center. It is a joint program, because MRE's are used by other military services.

The Army, however, does not make the MRE's. Various contractors, who must follow military specifications given to them by the Soldier Support Center, make them. Contents of MRE's can vary slightly from contractor to contractor as long as they meet the basic nutrient requirements established by the Office of the Surgeon General in AR 40-15, and set out in the specifications. Additionally, the Office of the Surgeon General must approve all menus.[26]

There are currently twenty-four different MRE menus. MRE meals are stored in brown, durable plastic bags. Each individual meal contains an entrée, crackers with either a cheese, peanut butter, jam, or jelly spread, a dessert or snack, a beverage, and an accessory pack that contains such items as coffee or tea along with sugar and cream.

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[25] "DOD Combat Feeding Program," SBCCOM, Online, 1.
[26] Meal, Ready-to-Eat," SBCCOM, Online.

Each meal contains an average of 1,250 calories kilocalories with the following break out of macronutients: 13% protein, 36% fat, and 51% carbohydrate.[27] These percentages equate to an average of 39.8 grams of protein, 52.8 grams of fat, and 161 grams of carbohydrate per meal[28] One of these meals is designed to provide the soldier one-third of the daily nutrient requirements set forth in AR 40-25. To get a full day's worth of the required nutrients, a soldier must eat three of these meals. Which means that a soldier would end up consuming an average of 3,750 calories a day, and would ingest on a daily basis 119.4 grams of protein, 158.4 grams of fat, and 483 grams of carbohydrate. By comparison, AR 40-25 lists the daily operational rations nutritional standards as 100 grams for protein, 440 grams for carbohydrates, and up to 160 grams for fat.

The AR states that the MRDA for protein is based, in part, on an estimated nutritional requirement of 0.8 gm/day/kg of bodyweight.[29] Based on the reference military range for military male personnel, this equates to a requirement of between 48 to 63 gm/day. The military, however, raised the MRDA to 100 grams per day to maintain a high level of palatability and food acceptance among military personnel.

For carbohydrates, the AR states that they should form the bulk of a soldier's diet contributing to between 50 and 55 percent of daily calories.[30] Of those calories the recommendation is that no more than 10 percent of daily calories should be made up of simple carbohydrates such as refined or processed sugars. The remaining carbohydrate calories, the AR states, should come from complex carbohydrates such as starches and naturally occurring sugars found in fruits, vegetables, and milk. The recommendation for fats is that dietary fat should not exceed 35 percent of total daily calories under garrison feeding conditions, but higher proportions of fat are acceptable in MRE's to increase caloric density.[31]

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[27] Ibid.
[28] MRE XIX – Mean Nutrient Analysis provided by SBCCOM.
[29] AR 40-25, Nutritional Allowances, Standards, and Education, 2-2.
[30] Ibid.
[31] Ibid.

In a discussion with the MRE manager at in the Combat Feeding program, it was determined that the military does not know which ingredients go into the MRE's because SBCCOM only requires that the contractors abide by the specifications in the contracting request document. They do, however, provide a list of recommended ingredients for each entrée, but these are for informational purposes only, and do not necessarily have to be followed by the contractors. The end result is that each contractor will utilize their individual recipes for the entrees.

The military also does not know what types and amounts of each fuel nutrient are contained in the MRE meals. For instance, they do not know which types and what proportion of different fats, such as saturated and monounsaturated, are contained in MRE's. This is due to the fact that the military does not require its' MRE contractors to divulge this information, and the contractors are not required to put food labels on their MRE bags. What this means, in essence, is that soldiers, don't know exactly what they are ingesting even though the FDA requires this sort of information be provided on all processed food sold in the U.S.

A rather recent development in the selection of MRE menu items is SBCCOM's, as the R&D agent for the Army, continual attempts at ensuring MRE's taste more like what the American population at large eats. In this effort, they rely heavily on feedback from the field in selecting menu items. Feedback that they gather from conducting MRE surveys several times a year.[32] This has resulted in SBCCOM adding over 80 new menu items, and replaced 14 items since 1993, and to make MRE's taste more like home they have incorporated into the MRE commercial items such as M&Ms and granola bars.[33]

THE STANDARD AMERICAN DIET

The United States, with its ideal geographical location, its abundance of fertile land, and some of the finest nutrition scientists in the world, has no problem producing all the food that

[32] "MRE Fast Facts," SBCCOM, Online, 1.
[33] Ibid.

would constitute an optimum diet. Unfortunately, the American diet leaves a lot to be desired, and, in fact, has led to an alarming number of diet-related disease and deaths. For instance, according to the National Institutes of Health, 35 percent of all cancer deaths and 30 percent of all cardiovascular disease deaths are directly related to diet.[34] Additionally, a recent review on diet and cancer estimates that up to 80% of cancers of the large bowel, breast, and prostate are due to dietary factors.[35] The American diet is currently the number two preventable cause of death in the U.S, right after smoking. Smoking kills about 425,000 people a year, and dietary mistakes kill about 350,000.[36] Diet in America has also been linked to Type II diabetes, osteoporosis, and a host of neurological disorders such as memory loss.

Additionally, compared to other similar developed nations, America's nutrition track record is deplorable. According to the World Health Organization (WHO), the U.S. ranks 24th in the world in their Disability Adjusted Life Expectancy (DALE) category, which is a measure of how long a nation's citizens live in "full health".[37] This puts the U.S. behind most all the developed nations in Europe, and several in the Far East. One of the primary reasons for this startling figure, according to the WHO, is the US's high rate of coronary heart disease, which as stated earlier is greatly effected by diet. . The American diet has gotten so bad that a growing number of nutrition scientists and nutritionists have begun to cynically refer to it as SAD, or Standard American Diet.

What may be even more staggering about the American diet, is the ever-increasing rate of overweight Americans. According to recently released data from the Center for Disease Control (CDC), an estimated 61% of adult Americans are overweight or obese, up from 56% in the early

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[34] Darma Singh Khalsa, M.D., Brain Longevity (New York, N.Y.: Time Warner Books, 1997), 200.
[35] "Food Choices for Health," Physician Committee for Responsible Medicine, Online.
[36] Ibid.
[37] "Health Life Expectancy Ranking," World Health Organization Online, 4 June 2000.

1990's,[38]and, as stated earlier, a recent study revealed that the military has not fared any better in this regard. To try to combat this weight epidemic, Americans have turned to diet aids to the tune of $33 billion a year,[39] but, unfortunately this has not slowed down America's ever increasing waistline. This has spurned a significant number of so-called nutrition experts who all profess to have the optimum diet to solve America's health dilemma, but who all seem to be drastically different in their approaches. It only takes a stroll through any bookstore, or taking a look at the latest best seller list to see the vast number of completely different optimum diets, and to see how this is effecting Americans. Unfortunately, these proclaimed "optimum diets" are not based on credible scientific studies, but, instead, are primarily based on unsubstantiated theories and casual observation.

This has lead to an overwhelming amount of often completely conflicting information, which has only confused the American public even more, and is only getting worse as they are bombarded on practically a daily basis with different theories on how to solve the diet problem. It has gotten so bad that last February the United States Department of Agriculture (USDA), whose charter it is to provide guidance to the American public on healthy eating, decided to step in, and hosted what was dubbed the "Great Nutrition Debate" between the two most popular diet proponents.[40] On one side was Dr. Robert Atkins, who believes the optimum diet is one that is high in protein and fat, and low in carbohydrates. On the other was Dr. Dean Ornish, who believes just the opposite, that the optimum diet is one that is high in carbohydrates, and low in protein and fats. Predictably, nothing was resolved during the debate, since neither diet guru is backed by scientific research. The end result is that the USDA is considering funding research to determine whom, if any one is right.

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[38] Nanci Hellmich, "CDC: 61% of U.S. Adults Overweight," USA Today, 14 December 2000, Health Section, 1.
[39] Elaine Gavalas, "The Great Diet Debate," Better Nutrition, Online, May 2000.
[40] Ibid.

Ironically, the USDA is probably already armed with all the information it needs to ensure the average American eats a healthy diet. The challenge is getting Americans to understand the critical role diet plays in overall health and longevity., and then convincing them to change their current diets. Fortunately, the Army's task is a little easier in that it provides the food that its soldiers eat. Its challenge is to ensure it takes the latest research from the nutrition science community, and uses that to provide soldiers optimal nutrition.

CHAPTER 3

LATEST RESEARCH ON NUTRITION

FAT

The scientific community has scrutinized fat, in the past decade or so, more than any other macronutrient. This is primarily because until recently fat has been implicated in most diet-related diseases, but, as will be shown, fat can play a significant role in healthy nutrition. In fact, fat in the right types and quantities can contribute to overall good health and any optimum nutrition program.

In U.S. society, fat has developed a bad reputation, one that is not necessarily deserved. It is definitely true that many people in America do consume too much fat, and that the consequences of a high-fat diet include an increased incidence of heart attacks, strokes, and cancer,[41] but it is also true that certain types of "healthy" fat have been proven to be essential for good health and disease prevention.

The key to understanding fat is to first understand that there are bad fats and there are good fats. The "bad" fat that is associated with diet-related diseases is known as saturated fat. So called because this type of fat remains solid or semisolid at room temperature, and that its' carbon atoms are "saturated" with hydrogen atoms.[42] This causes saturated fats to be virtually biologically inert.[43] Saturated fats are found primarily in animal foods such red meats, butter, whole milk products, and also in certain tropical oils such as coconut and palm oils.

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[41] Encyclopedia of Sports Science, "Nutrition and the Athlete," 728.
[42] Michael Colgan, Ph.D., Optimum Sports Nutrition (Ronkonkoma, New York: Advanced Research Press, 1993), 80.
[43] Ibid.

The deleterious effect on health and optimum performance caused by ingesting saturated fats has been recognized and addressed by government health authorities and every major health organization in America. Organizations such as the USDA, the American Heart Association, and the American Cancer Society all agree that humans should limit their intake of saturated fat to less than 10% of their daily calories. They have also acknowledged, albeit only within the past ten years, based on numerous studies, that saturated fat has been implicated in heart disease and in certain types of cancer. This is, therefore, the fat that should be avoided by any health conscious individual.

Interestingly, AR 40-25 recommends total daily fat limits, but makes no such recommendations for saturated fat. In fact, saturated fat is not even mentioned in the chapter on nutritional allowances and standards. Ironically, it is covered in the chapter on nutrition education where military personnel at risk of heart disease are cautioned to reduce saturated fat levels in their diets. Not surprisingly, SBCCOM does not require its MRE manufacturers to limit the amount of saturated fat in their products, just the amount of total fat.

Even more concerned with saturated fat than the government health authorities, are a number of prominent sports nutrition scientists such as Dr. Michael Colgan. In his highly regarded book Optimum Sports Nutrition, Dr. Colgan advises that to achieve optimum sports nutrition athletes should make every effort to eliminate saturated fats from their diets.[44] He argues that the only biological role saturated fats play is as calories, to be burned for energy, and because almost all athletes carry more energy reserve of fat than they will ever use, they have no need for saturated fats at all. Since the average soldier carries as much, or most likely more, body fat than the lean athletes which Dr. Colgan advises, there should be no room in a soldier's diet for saturated fats.

The fats that are considered "good" are the unsaturated fats, monounsaturated and polyunsaturated. In contrast to saturated fats, these unsaturated fats are liquid at room

[44] Ibid., 81.

temperature, and have empty spaces where hydrogen atoms are missing. These empty spaces make unsaturated fats much more biologically active.[45] Monounsaturated fats are found in foods such as olives, olive oil, and peanuts. Polyunsaturated fats are found in such foods as fish, corn, and wheat.

All food fats are composed of fatty acids,[46] and the polyunsaturated fatty acids are further subdivided into omega-3 and omega-6 fatty acids. These two fatty acids, also known as linoleic acid and alpha-linolenic acid respectively, are called essential fatty acids because they are essential for normal growth and development, and they cannot be manufactured by the body.[47] . They are basically chemicals that the body needs to make hormones and other compounds that are necessary for life itself.[48] They are required for normal growth, the maintenance of cell membranes, and healthy arteries and nerves.[49]

There is, however, a down side to omega-6 fatty acids. According to the research conducted on the effect of omega-6 fatty acids on the human body, too much of a good thing is not necessarily good. For example, studies show that omega-6 fats, although they are essential for some functions, also produce inflammatory chemical messengers called prostaglandins (a form of eicosanoid which is a hormone-like molecule) that promote cancer growth.[50] It has also been found that a diet high in omega-6 fats will cause the body to produce proinflammatory eicosanoids increasing the risk of asthma, allergies, arthritis, and other inflammatory diseases.[51]

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[45] Ibid., 80.
[46] Ibid.
[47] Artemis Simopoulos, M.D., The Omega Diet (New York, NY: Harper Collins Publishers, 1999), 45.
[48] Sinatra, Optimum Health 59.
[49] Susan M. Kleiner, Ph.D., Power Eating (Champaign, IL.: Human Kinetics Publishers, Inc., !998), 60.
[50] Michael Colgan, Ph.D., The New Nutrition: Medicine for the Millennium (Vancouver, Canada: Apple Publishing, 1995), 148.
[51] Simopoulos, The Omega Diet, 43-44.

Fortunately, omega-3 fats act in the body to produce a different type of eicosanoids that counter the negative effect of the omega-6 produced eicosanoids.[52] Numerous studies have been conducted on omega-3 fats that clearly show the beneficial effects of omega-3's. Not surprisingly, based on their countering effect on omega-6 fats, the Journal of the National Cancer Institute declared that omega-3 fats have potential clinical usefulness in cancer treatment.[53] There is impressive evidence that omega-3 fats go a long way to inhibit cardiovascular disease, adult-onset diabetes, some skin diseases, and rheumatoid arthritis.[54] Just last October, the American Heart Association, that tends to be cautious in issuing new nutritional guidance, released new dietary guidelines that recommend that Americans eat fatty fish, which is high in beneficial omega-3 fatty acids, twice a week.[55]

From the existing research it is clear that optimum nutrition requires a careful balancing of omega-3 and omega-6 fatty acids, but what proportion of each should humans eat? That question was recently answered by William Lands, Ph.D., a world-renowned authority on fish oil at the National Institutes if Health, and a group of international experts on fatty acids. Dr. Lands and colleagues recommend eating balanced ratio of omega-6 fats to omega-3 fats of 1 to 1.[56] Interestingly, medical anthropologists believe that our stone-age ancestors ate a diet in this recommended ratio of omega-3 fats to omega-6 fats.[57] They also believe that human cells evolved over thousands of years being fed this balanced ratio, and that it is only recently, in evolutionary terms, that our humans have eaten a preponderance of omega-6 fats.[58] By contrast, it is estimated that in the current American diet the ratio of omega-6 fats to omega-3 fats is from

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[52] Colgan, The New Nutrition: Medicine for the Millennium, 148.
[53] Ibid.
[54] Michael Colgan, Ph.D.., Essential Fats: All you Need to Know About Fat Intake (San Diego, Calif.: C.I. Pubilcations, 1994).
[55] "American Heart Association Dietary Recommendations Dish Out a More Individualized Approach," American Heart Association, Online, Oct. 5, 2000.
[56] Jean Carper, Your Miracle Brain (New York, N.Y.: Harper Collins Publishers, 2000), 64.
[57] Ibid., 43.
[58] Ibid., 42.

14 to 1 to 20 to 1.[59]

The other beneficial "good" fat, monounsaturated fat, has just recently started to receive a tremendous amount of attention from the scientific community. The media has been quick to pick up on this as numerous newspaper and magazine articles have covered studies on the health promoting benefits of olive oil and nuts, which are high in monounsaturated fats. Thus far, the more studies that are done on this type of fat, the more is revealed on how it plays an integral role in maintaining a healthy heart.

What the studies have shown, for instance, is that monounsaturated fats are truly unique in the way they effect blood cholesterol levels. Monounsaturated fats are the only category of fats that have been proven to lower low-density lipoprotein (LDL) levels, commonly referred to as bad cholesterol, and to raise high-density lipoprotein (HDL) levels, commonly referred to as good cholesterol.[60] This is significant in that LDLs take cholesterol into blood vessels, whereas HDLs carry it out of the body. Monounsaturated fats, therefore, have a positive effect on blood cholesterol levels. High levels of cholesterol, of course, have been linked to increased risks of heart attack or stroke. Additionally, a study published in the Journal of the American Medical Association determined that eating more monounsaturated fats could reduce the risk of stroke in men.[61]

Recent research also indicates that monounsaturated fats also may play a role in preventing certain types of cancer. A study published in the Annals of Internal Medicine indicated that people who ate diets that were higher in monounsaturated fats lived longer and had less incidence of cancer than those on low-fat regimens.[62]

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[59] Simopoulos, The Omega Diet, 36.
[60] Simopoulos, The Omega Diet, 54.
[61] "New Research Suggests that The Omega Diet is the World's Healthiest Diet," Teleport, Online, 2.
[62] Dave Tuttle, "Fit for Fat: Can Eating too Lean Starve Your Muscles," Men's Fitness, April 1999, 42.

The monounsaturated fat food that has received the most attention lately, and for good cause, is olive oil. Olive oil contains high levels of a monounsaturated fatty acid called cis-oleic acid that has been shown in repeated studies to be particularly effective in lowering serum cholesterol, and has other beneficial effects on blood lipids.[63] Additionally, a 1996 study, although relatively small in scale, revealed that olive was effective in lowering blood pressure.[64] If that wasn't enough, olive oil also contains more than 200 micronutrients, some of which are effective antioxidants.[65] Olive oil is truly the superstar of the monounsaturated fat food family, and worthy of consideration when developing an optimal nutrition program.

There is another category of fatty acids that is worth mentioning, and that is the hydrogenated or trans fatty acids. To borrow from Sergio Leone's movie "The Good, the Bad, the Ugly", if unsaturated fats are the "Good", and saturated fats are the "bad", then clearly trans fats are the "ugly."

Trans Fatty acids, which are often found in processed foods and commercial baked goods, are vegetable oils that have had extra hydrogen molecules added to them to make them solid at room temperature and also to extend self life.[66] Hardly any trans fatty acids occur in nature, so the human body has never developed the mechanisms necessary to use them.[67] Today, in America almost all processed fat and oil products, cooking oils, margarines, and fats used in breads, cookies, frozen dinners, and processed meats contain high levels of trans fatty acids.[68] Trans fatty acids are also used as the primary hardening ingredient in processed foods.[69] Trans fats can be identified on food labels by the words hydrogenated or partially hydrogenated.

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[63] Colgan, Optimum Sports Nutrition, 83.
[64] Simopoulos, The Omega Diet, 52.
[65] Vigilante and Flynn, Low-Fat Lies, High-Fat Frauds, 163.
[66] Sinatra, Optimum Health, 57.
[67] Colgan, Optimum Sports Nutrition, 88.
[68] Ibid.
[69] Robert Arnot, M.D., Dr, Bob Armot's Revolutionary Weight Control Program (Boston, Mass.: Little, Brown and Company, 1997), 90.

So what make trans fatty acids so ugly? Trans fats acids behave in many ways like saturated fat, including raising LDL levels.[70] What makes them truly ugly is that, unlike saturated fat, they also lower HDL levels.[71] Several recent studies, to include several published in the "New England Journal of Medicine" clearly show a direct relationship between the consumption of trans fatty acids and heart disease.[72]

The whole of Europe, which recognizes the dangers of consuming trans fatty acids, has had mandates against them for some years.[73] On this side of the ocean, the American Heart Association has recognized the negative effect trans fatty acids have on the human heart, and acknowledge that a diet that includes trans fatty acids has been shown to raise LDL levels and lower HDL levels.[74] Their recommendation, therefore, is to eliminate foods containing hydrogenated oils from the diet, and use unhydrogenated vegetable oils instead.[75]

Since different kinds of fat can be either beneficial or detrimental to one's health, exactly how much total daily dietary fat is considered optimum? The United States Department of Agriculture[76] and the American Heart Association[77] clearly indicate, as they have done for years, that no more than 30% of daily dietary calories should come from fat.

Government health authorities and health organizations recommendations', however, tend to be conservative and are primarily designed to keep average Americans healthy. Sports nutritionists, on the other hand, are concerned primarily with making dietary recommendations that will result in optimum athletic performance. In other words, their focus is on optimum nutrition for optimum athletic performance. With that said, the vast majority of the sports

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[70] Simopoulos, The Omega Diet, 33.
[71] Ibid.
[72] Colgan, The New Nutrition: Medicine for the Millennium, 145.
[73] Ibid.
[74] "Dietary Guidelines," American Heart Association, Online.
[75] Ibid.
[76] "Dietary Guidelines for Americans," United States Department Of Agriculture, Online, 2000, 30.
[77] "The Details: Fat & Fatty Acids," American Heart Association, Online, 2.

nutrition literature reviewed revealed that sports nutritionists recommend far less daily dietary fat, between 15% and 25% of daily calories, than government authorities and health organizations do.

Dr. Michael Colgan, for instance, recommends that active people such as athletes keep total fat intake below 15% of daily calories.[78] Besides his personal research, he cites the studies done on the Mexican Tarahumara Indians who even in their 50's perform fantastic running feats of 100 miles or more on diets that get only 9-12% of their calories from fat.[79] He also cites studies done on countries with low rates of degenerative disease such as Japan, where calories from fats are about 15% of the daily diet.[80] Other notable sports nutritionists, such as Nancy Clark recommend that active people should aim to keep their daily intake of dietary fat to no more than 25% of total calories.[81]

The military does make recommendations of its own on daily fat intake in AR 40-25. In it, it is recommended that the calories from dietary fat should not exceed 35% under garrison feeding conditions, but that higher proportions of fat calories are acceptable in operational rations to increase caloric density.[82] This is reflected in MRE's that average 36% fat per menu. Clearly, the military's recommendations are not in line with the prevailing research that has been conducted on the harmful effects of consuming too much fat, and its affect on athletic performance.

PROTEIN

Protein has not caused nearly as much controversy in the scientific community as fat, but it nonetheless has stirred some discussion between government health authorities and sports nutritionists, and more recently it has been touted by several self-proclaimed nutrition experts as a

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[78] Colgan, Optimum Sports Nutrition, 87.
[79] Ibid.
[80] Ibid.
[81] Nancy Clark, MS, RD, Sport Nutrition Guidebook (Champaign, IL: Human Kinetics Publishers, 1990), 32.
[82] AR 40-25, 2-2.

cure-all for America's health problems. The core of the discussion being centered on the fact that government health authorities such as the USDA or the FDA make their dietary recommendations for average American sedentary people. The sports nutrition community is concerned with the protein requirements of active people, and they believe that active people require more protein than is currently recommended by government health authorities. As far as some of the health claims made by high protein diet proponents such as Robert Atkins, none of their claims have been backed up by scientific studies.

First of all, what is protein and what functions does it perform in the human body? Protein of course is a macronutrient , but, unlike fat and carbohydrate which contain only carbon, oxygen and hydrogen, it also contains nitrogen and other elements essential for life.[83] It also different from the other fuel macronutrients in that it won't cause the health problems that are associated with eating the wrong types of fat or carbohydrate. In other words eating protein will not cause heart problems and diabetes for instance.

Proteins are made up of 22 different amino acids, thirteen of which are considered nonessential, those that can be produced by the liver, and nine that are considered essential, those that the body needs from the diet. The human body produces approximately 80% of the amino acids it needs, and the remaining 20% must be obtained from protein food sources.[84] Protein food sources are either complete proteins, foods containing all the essential amino acids, or incomplete, foods that do not contain all the essential amino acids. Food from animal sources has complete proteins, while food such as grains, vegetables, and fruits do not. The one exception to this is the soybean, which is a complete protein food.

Humans, however, don't need to rely solely on complete protein food sources to get all their essential amino acids, they can match incomplete protein foods with other incomplete protein

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[83] Patricia Deuster, Ph.D., Pierre Pelletier, M.D., Anita Singh, Ph.D., The Navy Seal Nutrition Guide (Bethesda, MD: Department of Military and Emergency Medicine, 1994), 21.
[84] Sinatra, Optimum Health, 31.

food which together have all the essential amino acids. This is in fact how strict vegetarians get all their essential amino acids without ever eating complete protein foods.

Protein has many important functions in the body. It makes up muscles, ligaments, tendons, organs, glands, nails, hair, and some body fluids.[85] It is also essential for developing new tissue, which is important during muscle growth and injury repair, and it is essential for maintaining existing tissue.[86] Additionally, protein performs the critical function of helping make the body's neurotransmitters.[87] It is evident, therefore, that protein plays a critical role in any optimum nutrition program, and especially for anyone in a physically demanding profession like the Army.

A key question, then, would be how much daily dietary protein is optimum for the human body? Government health authorities have established the RDA for protein as 0.8 grams/day/kilogram of body weight.[88] The military, as expressed in AR 40-25, uses this RDA for protein as the benchmark for its recommended allowance. In establishing its MRDA for protein, however, it takes the RDA amount and then it approximately doubles that amount to 100 grams per day for males. Interestingly, it doubles the RDA amount not because it sees a need to supply soldiers with more protein, but because it believes that this increased amount will maintain a high level of palatability and food acceptance among military personnel.[89] In other words, it tries to mirror the Standard American Diet. It should be noted that based on the information provided by SBCCOM, the actual daily average protein value is 119 grams per day not 100 grams.

Just how relevant to the Army is the Food and Nutrition Board's RDA for protein? When you consider that when the Food and Nutrition Board established the current RDA they studied only sedentary individuals and that no allowances were made for physical activity,[90] its relevancy

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[85] Ibid.
[86] Dan Benardot, Ph.D., RD, Nutrition for Serious Athletes (Champaign, IL: Human Kinetics, 2000), 6.
[87] Carol A. Rinzler, Nutrition for Dummies (Foster City, CA.: IDG Books Worldwide, Inc. 1999), 68.
[88] Kleiner, Power Eating, 18.
[89] AR 40-25, 2-2.
[90] Colgan, Optimum Sports Nutrition, 145.

should be questioned. Soldiers are far from sedentary, and if anything, they are certainly one of the most physically active professions in American society. Clearly, when taking into account how protein is utilized by the human body, and how it maintains and builds lean muscle mass, it doesn't make much sense to compare the protein needs of someone who spends his days behind a desk to someone who spends long hours in some of the most physically demanding conditions.

This raises the question, then, of how much protein is optimum for today's soldiers. Perhaps the best place to look is in the field of sports nutrition where several research studies have been conducted on the effect of protein on physical activity. At Tufts University, for example, Dr William Evans and colleagues, at the USDA Human Nutrition Research Center, have shown that men who regularly exercise with the endurance sports of running, cycling, or swimming require more protein than the RDA. Their findings show that regular, moderate endurance exercise increases protein needs to about 1.4 g/kg/day, or about double the RDA.[91]

In another relevant study, Dr Peter Lemon, one of the nation's leading experts on protein, at Kent State University, showed that strength-training athletes require at least 1.6 g/kg/day. Dr Frank Consolazio at the former Letterman Army Institute of Research showed in his research that the more intense the physical activity is, the greater will be the requirement for protein. In his study he gave healthy men either 1.4 g/kg/day or 2.8 g/kg/day, and then had them train to near exhaustion for 40 days. The studies results showed that the subjects on the lower protein diets gained 1.21 kg of lean mass, while the subjects on the higher protein diet gained nearly three times as much lean mass at 3.28 kg.[92]

This last study certainly may have tremendous relevance to special population Army groups such as the Rangers who often push themselves to their physical limits, not unlike the subjects in

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[91] Tufts University Diet & Nutrition Letter. "How Much Protein do Athletes Really Need," 1987; 5:1.
[92] Colgan, Optimum Sports Nutrition, 148.

Dr Consolazio's research project. Studies such as this one, clearly show that groups like the Rangers have protein needs that exceed what they normally would get from ingesting three MRE meals a day. Other Army groups such as, for example, light infantry units, who often travel great distances on foot carrying heavy loads, may also have greatly increased protein needs.

For physically active individuals, such as athletes and Army soldiers, the sports nutrition community has devised daily protein requirements based on the type of activity. The requirement, then, for physically active individuals is thought to be between 1.5 and 2.0 g/kg/day,[93] or two to three times the RDA. The lower end of the range is for recreational exercisers and the top end for elite bodybuilders and endurance athletes in hard training.[94] Since soldiers are hardly recreational exercisers, it would make sense that their protein needs would be closer to the top end of the range. Interestingly, athletes engaged in sports involving both strength and endurance have the greatest needs of all; they require up to 2.2 g/kg/day.[95] A convincing argument could probably be made that certain soldiers fall into this highest protein needs category.

If one were to compute a soldier's daily protein requirements, therefore, using the mid-range of the above figures, which would be 1.75, it would definitely be greater than the MRDA. Taking the Army's reference body weight range, which is used to compute the MRDA for protein, of 60 to 79 kilograms (132 to 174) for males, the new protein requirements would be 105 to 138 grams of protein per day. Although this is beyond the scope of this monograph, it would certainly not be surprising to find that the reference body weight range used is lower than what actually exists today, which, of course, would make the protein requirements even higher.

CARBOHYDRATE

To understand the role carbohydrates play in the human body, one must first compare them to

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[93] Denardot, Nutrition for Serious Athletes, 16.
[94] Clarence Bass, Challenge Yourself: Leaness, Fitness, and Health at any Age (Albuquerque, N.M.: Ripped Enterprises, 1999), 31.
[95] Ibid.

the other fuel nutrients. Protein and essential fats are predominantly building materials. That is there are used to build and repair tissue, and their effect is long term. [96] Carbohydrates, on the other hand, are the body's primary and preferred fuel. They are the favorite fuel of exercising muscle cells and are the only fuel brain cells can use.[97] Their effect, however, is short term much like the fuel in a car's tank. The body has a limited storage capacity for carbohydrates and must, therefore, be replenished every day for the body to continue to function properly. Clearly, without them, the body would literally run out of gas. Although, it must be pointed out that when the body senses its carbohydrates stores have been depleted, it will start breaking down muscle tissue for fuel,[98] which will result in the loss of body muscle to feed the brain..

Carbohydrates, whose name means "carbon plus water", are sugar compounds made by plants.[99] There are basically two types of carbohydrates; simple carbohydrates, and complex carbohydrates. What makes carbohydrates different from each other is how many sugar units they contain and how the units are linked together.

Glucose, or blood sugar, is what carbohydrates are broken down into during the body's digestive process. It, in turn, is transported in the blood to the brain, the nervous system, the liver, and to muscle tissue. The body maintains a certain level of glucose in the blood to serve the brain and central nervous system.[100] To ensure a ready available supply of glucose, the body stores glucose, in the form of glycogen, in the muscles and the liver.[101] Two-thirds of the body's glycogen is stored in the muscles and about one-third is stored in the liver.[102] This is particularly important to physically active populations such as athletes and soldiers as it is this glycogen

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[96] Colgan, Optimum Sports Nutrition., 95.
[97] Encyclopedia of Sports Nutrition., "Nutrition and the Athlete," 722.
[98] Jennie Brand-Miller, The Glucose Revolution (New York, N.Y.: Marlowe and Company, 1999),11.
[99] Rinzler, Nutrition for Dummies, 91.
[100] Brand-Miller, The Glucose Revolution, 11.
[101] Ibid.
[102] Kleiner, Power Eating, 36.

which provides the major source of fuel for working muscles,[103] and there is a finite amount of glycogen that can be stored by the body at any one time.

To get the glucose into cells where they are needed, the pancreas produces a hormone called insulin. Insulin sends a signal to the body's muscle cells that they need to take up the glucose either as an energy source or to be stored as glycogen.[104] Recent research, however, has shown that problems may occur when high glycemic index carbohydrates cause a surge in insulin levels. The Glycemic index, developed by Dr David Jenkins and colleagues at the University of Toronto, is the ranking of foods from 0 to 100, with 100 being the fastest, that tells whether a food will raise blood sugar levels dramatically, moderately, or slowly.[105]

Each time the body ingests a significant amount of high glycemic index carbohydrates, therefore, there is a corresponding surge of insulin to respond to the glucose production. If this process is repeated over and over again, whereby one high-glucose meal after another is consumed, an incredible amount of strain is inflicted on the body's blood vessels which would be crammed full of glucose.[106] Even more significant to optimum health, is the fact that the increased insulin produced by the body has been linked to such health maladies as diabetes, high blood pressure, increased risk of cancer, and increased risk of heart disease.[107]

There is however a simple solution to guard from this happening, and that is to insure that the majority of the carbohydrates consumed are of the low or moderate glycemic index. The significance to the Army obviously is that ideally the carbohydrates in the MRE's should be of the low to moderate glycemic index variety. This is even more significant when considering the fact that the lower the glycemic index the slower will be the release of insulin into the blood stream, which results in a steady stream of energy producing glucose into the blood stream. As

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[103] Ibid.
[104] Simopoulos, The Omega Diet, 75-76.
[105] Brand-Miller, The Glucose Revolution, 21.
[106] Armot, Dr. Bob Arnot's Revolutionary Weight Control Program, 68.
[107] Ibid., 70.

compared to the effect of eating a high glycemic index meal, which gives the instant "sugar high", and then leaves the body drained of energy.

There is, of course, no mention made of the effect or the dangers of consuming high glycemic index meals in AR 40-25, as the research is too recent to have been included in the regulation. A review of the MRE meals provided by SBCCOM to the author reveal that the carbohydrates in the meals tend to be of the high glycemic index variety. To make matters worse, recent research has determined that eating large amounts of saturated fat coupled with high glycemic index foods is the worst possible combination, as the two combined are much worse than eating the two separately.[108] Since, as has already been pointed out, MRE meals tend to be high in saturated fat, this would overload the blood vessels with glucose even more, a situation which is definitely not compatible with optimum nutrition.

Is there ever a situation where high glycemic index foods are beneficial? Sports nutrition scientists have determined that the answer to that question is yes, but only after intense periods of physical activity. Remember that the human body has a limited storage capacity for glucose, and that the harder the muscles work the more quickly they will burn up glucose. Interestingly, sports nutritionists have found that the muscles are the most receptive to producing new glycogen stores within the first few hours after a workout, and the best way to do that is with high glycemic index foods which have been shown to replace depleted glycogen stores best.[109] This fact could prove useful to the Army whose soldiers will undoubtedly have periods of intense physical activity whereby their glycogen stores need to be replaced quickly.

In light of all the research that has been conducted on dietary fiber, no discussion of carbohydrates in relation to optimum nutrition would be complete without mentioning this important type of complex carbohydrate. Government health officials and nutrition scientists have devoted a tremendous amount of time and effort on promoting the health benefits of a diet

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[108] Ibid., 74.
[109] Kleiner, Power Eating, 48-49.

high in dietary fiber. The National Cancer Institute, The American Heart Association, the National Academies of Science, and the United States Department of Agriculture have all come out with dietary recommendations for fiber.[110] They have done so because a lack of fiber in the diet has been associated with gastrointestinal diseases, hypertension, diabetes, heart disease, and several types of cancer, whereas a high fiber intake is associated with decreased risk.[111] The other added benefit of fiber, is that it helps keep the body's insulin level steady and promotes use of the food for energy rather than for deposition as bodyfat. [112]

As far as specific recommended amounts of daily fiber, all the above health organizations are basically in concurrence that the more the better. The recommended dietary intake, however, has been established at between 20-35 grams of fiber per day, with the amount dependant on the number of calories consumed. In other words, the more calories in a diet the more fiber would be required. To simply this, the USDA has set the fiber recommendation at 5 grams per every 500 calories consumed. So, for instance a 2,500-calorie diet would require 25 grarns of fiber. This calculation can be found on the Nutrition Label on any processed food found in the local supermarket.

What this all means is that for the average daily calories found in the required three MRE meals, approximately 3,600 calories, the corresponding recommended dietary fiber intake would be at least 35 grams. In actuality, however, the average daily dietary fiber found in a day's worth of MRE's is only 20.75 gram. At 40% less than the daily recommended dietary intake, this is significantly lower than what health officials feel is necessary for preventing disease and maintaining good health.

It should also be noted that leading sports nutrition experts such as Dr. Colgan recommend amounts even higher than those recommended by government health authorities and health

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[110] Deuster, Pelletier, and Singh, The Navy Seal Nutrition Guide, 46.
[111] Ibid.
[112] Colgan, The New Nutrition: Medicine for the Milennium, 175.

organizations. Dr. Colgan believes that for optimum athletic performance, athletes should eat 40 -50 grams of fiber per day.[113] This amount being more than double the daily amount found in MRE's.

The last question to be answered about carbohydrates is how much is considered optimum? Government health authorities have established the RDA for carbohydrates as 60% of daily calories. For a 2,000-calorie diet, for instance, the RDA is 300 grams of carbohydrates or 60% of total calories. A review of the sports nutrition literature reveals that the sports nutrition community recommends consuming about the same. They recommend that 60-70% of daily calories be in the form of carbohydrates.[114][115] The higher value being recommended prior to intense endurance events. There is also concurrence as to what type of carbohydrates are preferred, with high fiber, complex carbohydrates (the low to moderate glycemic index variety) being recommended as to what should make up the majority of daily carbohydrate calories. The only exception to this, as already noted, is the sports nutritionists' recommendation to consume high glycemic index carbohydrates after physical activity.

As pointed out in Chapter 2, the Army in AR 40-25 recommends that a soldiers diet should be comprised of 50-55% carbohydrates, with the bulk of that being complex carbohydrates. In Chapter 2, it was also pointed out that in actuality carbohydrates make up 51% of the total calories in a MRE meal. These percentages, of course, fall far short of the recommendations given by both the government health authorities and the sports nutrition community.

SODIUM

Although not a fuel nutrient, sodium is included in this study because of all the press, and recent studies it has been the topic of. More importantly, it is included because of its effect on

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[113] Ibid., 176.
[114] Benardot, Nutrition for Serious Athletes, 164.
[115] Clark, Sports Nutrition Guidebook, 109.

optimum health, and in particular its effect on blood pressure.

Sodium is one of the three main electrolytes, the other two being potassium and chloride. All three serve the purpose of keeping the body's fluid levels balanced. Sodium's primary role is to regulate fluid balance outside cells, while its counterpart, potassium, regulates fluids inside cells.[116] This is an important point as studies have shown that there is a link between the proportion of sodium to potassium that is consumed and overall health, and this is a subject that will be covered later in this section.

The American Heart Association and the USDA both agree that the Americans should limit their intake of sodium to 2,400 milligrams (mg) per day.[117][118] Their recommendation for limiting sodium is driven by the fact that many studies on diverse populations have shown that a high sodium intake is associated with higher blood pressure.[119] Of concern to these organizations is the fact that Americans on average consume about 3,300 mg per day, and that almost 50 million Americans suffer from high blood pressure.[120]

The AHA and the USDA's recommendations may, however, have to be reevaluated based on a recent study conducted by the Harvard Medical School. Its results, which were published in The New England Journal of Medicine earlier this year, reveal that proper diet can reduce blood pressure just like medicine can.[121] More importantly, the study reveals that the current dietary recommendation may be too high. The study's authors found the optimal level of sodium intake to be 1, 500 milligrams per day,[122]which is less than half what the average American consumes a day.

To make matters even worse, the standard American diet does not have adequate amounts of

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[116] Kleiner, Power Eating, 103.
[117] "2000 Dietary Guidelines for Americans," 34.
[118] "American Heart Association Eating Plan," 3.
[119] "2000 Dietary Guidelines for Americans," 34.
[120] Steve Sternberg, "Dietary Approach Lowers Blood Pressure," USA Today, Online, 2.
[121] The New England Journal of Medicine, Vol. 344, No. 1, Jan 4, 2001.
[122] Ibid.

potassium. This is critical because a number of well-documented studies clearly indicate that potassium helps lower blood pressure and helps prevent strokes. [123] A growing concern among nutritionists is the fact that over the years the American diet has shifted from a healthy potassium to sodium ratio, which is found in all fresh foods, of 7:1, to a diet which now has more sodium than potassium in it.[124] Average potassium intake in America has fallen to 2,500 mg per day, as compared to USDA's recommended intake of 3,500 mg per day.[125] This fact, in effect, has compounded America's dietary woes.

By contrast, Army operational rations contain an average of 1,941 mg sodium and 1,168 mg potassium per MRE. [126] This equates to a daily consumption of 5,823 mg sodium and 3, 504 mg potassium. Clearly, the sodium amounts are much higher than the USDA and AHA recommendations, and significantly higher than what is proposed in the latest Harvard University study. The potassium levels do meet recommended amounts, but this is offset by the large amount of sodium. Not surprisingly, the potassium to sodium ratio is comparable to what exists in the average American diet.

AR 40-25 states that 3,300 mg of sodium per day represents the lowest acceptable limit to which the American population can adapt, because the average young civilian male consumes approximately 5,500 mg sodium per day (this number is larger than the current figure, because it is based on data that is nearly two decades old) in food. [127] The regulation also sets the Army's target daily intake level for sodium at 5,500 mg for males and 4,100 for females.[128] Since both sexes eat the same MRE's, it is interesting to that the Army would set such targets.

Are there any population groups that require more sodium than they average sedentary population? Years ago it was thought that individuals who perform hard physical work,

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[123] Carper, Your Miracle Brain, 324-325.
[124] Colgan, The New Nutrition: Medicine for the Millenium, 93.
[125] Ibid.
[126] Amounts provided by SBCCOM.
[127] AR 40-25, 2-3.
[128] Ibid., 2-4.

especially in higher temperatures, required more sodium because of the amounts thought to be lost in the sweat. However, this was not backed up by any research. It has since been determined, that unless an individual is participating in an ultra-endurance event such as an Ironman length triathlon or a 100-mile race, the body does not require extra sodium.[129] Although physically active folks such as athletes lose a little sodium under ordinary conditions, they do not come close to depleting their body's stores.[130] The human body simply does not lose that much sodium through sweating, and although there may be isolated cases whereby a soldier would require higher levels of sodium, all indications are that the average soldier under most conditions will do just fine by staying within USDA recommendations

CREATINE MONOHYDRATE

Few sports nutrition supplements are backed up by scientific research that proves their worth. Creatine monohydrate is one of those rare exceptions. Like sodium, creatine monohydrate is not a fuel nutrient, but because it has proven benefits which the Army may find useful, and which certainly should be considered when devising an optimal nutrition program, it has been included in this monograph. It is the only supplement that will be included in this study because it is backed up by numerous studies, and because most other supplement claims are unfounded.

Creatine monohydrate or just simply creatine is a substance produced by the liver and kidneys, at a rate of two grams per day, from three essential amino acids arginine, glycine, and methionine.[131] Inside muscle cells, creatine is turned into a compound called creatine phosphate (CP).[132] CP is critically important in that it replenishes the body's cellular reserves of adenosine triphosphate (ATP), which is the molecular fuel that provides power for muscular contrations.[133] Simply stated, when more creatine is present in the body, an individual can work out harder for

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[129] Colgan, Optimum Sports Nutrition, 195.
[130] Clark, Sports Nutrition Guidebook, 133.
[131] Kleiner, Power Eating, 128.
[132] Ibid.
[133] Ibid.

longer periods of time, and recover faster. Certainly, this is something that the Army might find useful for their soldiers, especially those who perform the hardest physical tasks.

In addition to the limited amounts of creatine produced by the body, it can also come from food sources such as red meat or fish. It would take, however, large quantities of these foods to have a performance enhancing effect. It must be taken, therefore, in supplement from to have any beneficial effects. As athletes at all levels from high school to pros quickly realized the potential of creatine, it resulted in a tremendous boom for the sports nutrition industry. In 1998 alone, $200 million worth of creatine was sold in the United States.[134]

Since nutrition scientists generally carefully scrutinize most new supplements claiming ergogenic, or performance enhancing,, effects, creatine was subjected to numerous university studies. Up to this point all studies have been impressive. Richard B. Kreider, Ph.D., Associate Professor at the University of Memphis, told The Physician and Sportsmedicine that 80% of creatine studies have shown an ergogenic effect.[135] Additionally, it was reported in the International Journal of Sport Nutrition that creatine should not be viewed as another gimmick supplement, because it has been shown to provide immediate, significant improvements to athletes involved in explosive sports.[136]

In light of all the evidence indicating the effectiveness of creatine monohydrate, this is one supplement soldiers could use to give them an additional edge, especially those with the most physically demanding jobs such as the elite Ranger units.

WORLD'S HEALTHIEST DIET

Since the American diet, which the Army bases its operational rations on, is obviously not the world's healthiest diet, than what is? This is an interesting question, which few nutrition

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[134] Bass, Challenge Yourself: Leaness, Fitness, & Health at any Age, 33.
[135] Ibid., 34.
[136] Kleiner, Power Eating, 128.

scientists have conducted comparative research on. One that did is Dr. Ancel Keys, who wanted to know which of the world's diets resulted in the lowest rates of fatal diseases such as cancer and heart disease.

Beginning in the late 1950's Dr. Keys and his colleagues amassed huge amounts of data on more than twelve thousand men from seven different countries – Finland, Greece, Italy, Japan, Yugoslavia, the Netherlands, and the United States.[137] The results of this exhaustive study revealed that the Greek Island of Crete had the lowest rates of death, cancer, and heart disease, with Japan coming in second.[138]

The study followed up on the participants during a fifteen –year period to ensure their original results were still valid. The results of this follow on study were published in 1984, and revealed that once again the Cretans faired the best.[139] Interestingly, after all the data in this landmark fifteen-year study were compiled, it showed that Cretans experienced half the cancer death rate and an astonishing one-twentieth the heart disease death rate as compared to Americans.[140]

Dr. Serge Renaud, of the University of Lyon in France, recently put the efficacy of the Cretan diet to the test in his famous Lyon Heart Study. During a four-year period, form 1994 to 1998, Dr. Renaud and colleagues, put heart attack survivors on either a Cretan diet, or on a diet similar to the one recommended by the American Heart Association. The results clearly showed that the Cretan diet was superior to the AHA-type diet in preventing heart disease, and that the longer the study continued the wider the survival gap became. The patients on the Cretan diet had a remarkable seventy-six percent lower risk of dying from cardiovascular disease or suffering heart failure, heart attack, or stroke.[141]

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[137] Vigilante and Flynn, Low-Fat Lies High-Fat Frauds and the Healthiest Diet in the World, 142.
[138] Ibid., 143.
[139] Ibid.
[140] Simopoulos, The Omega Diet, 7.
[141] Ibid.

What differentiates the Cretan diet from other diets of the world is its low rate of saturated fats, coupled with its high rate of omega 3 fatty acids and monounsaturated fats from olive oil. This should not come as a great surprise since, as was pointed out earlier in the monograph, recent studies have shown the health producing benefits of lowering or eliminating saturated fats and replacing those with healthy polyunsaturated and monounsaturated fats.

If the Army is looking for a diet other than the Standard American Diet to emulate, they could definitely not go wrong with the Cretan diet.

CHAPTER 4

CONCLUSION AND RECOMMENDATIONS

Based on current research in the field of nutritional science, the Army's operational rations are far from being optimal because of three primary reasons. Clearly, two of the fuel nutrients, fats and carbohydrates, are not in the right quantities and mix in MRE's to make them optimal. Thirdly, recent studies indicate conclusively that the quantities of sodium in MRE's are simply too high.

The first and foremost reason the Army's operational rations are not optimal is the extremely high fat content. As has been shown, the whooping MRE fat content of 36% of total daily calories is much higher than the recommendations made by the USDA and every major health organization devoted to disease prevention such as the AHA and the American Cancer Society, not to mention the recommendations by prominent sports nutritionists to keep fat levels at 15% to 20% for optimal physical performance.

Even worse than the high fat content, are the types of fat found in MRE's. Research has shown that "healthy fats" such as polyunsaturated omega 3's and monounsaturated fats should definitely be part of a healthy diet. MRE's, however, are basically void of these healthy fats, as there is no requirement for contractors to include them in their recipes, nor are they even mentioned in contracting request documents from SBCCOM to the contractors.

Additionally, nutrition science has clearly shown a link between consumption of "bad fats" such as saturated fats and trans fatty acids, and a host of diseases. Consequently, government health authorities and all health organizations recommend that daily calories be restricted to no more than 10% saturated fat and to eliminate trans fatty acids as much as possible. Sports nutrition scientists, such as Dr, Colgan go a step further and recommend the elimination of all these bad fats as they argue that they have no room in an optimal diet. AR 40-25 and SBCCOM,

however, make no such restrictions on these bad fats, which leaves the MRE contractor the latitude to include as many of these fats as they want. Additionally, since the Army does not require the contractor to provide them with a nutrient breakdown, they have no way of knowing what percentage of bad fats is included in MRE's.

The second reason MRE's are not optimal is the quantities and mix of carbohydrates. As the workhorse of fuel nutrients for physically active individuals it is imperative that quality carbohydrates be provided on a daily basis. Specifically, there is convincing evidence that for optimal nutrition carbohydrates should be of the low to moderate glycemic index variety. In MRE's, however, the mix is primarily of the moderate to high glycemic index variety. In addition, a review of the most recent literature on the subject reveals that sports nutritionist recommend that carbohydrates comprise 60% to 65% of daily calories, which matches USDA recommendations, whereas in MRE's that percentage is only 51% largely due to the high fat content. The Army would do well, therefore, if they replaced the fat calories in MRE's with complex carbohydrate calories.

MRE's are also severely lacking in their fiber content. There is an enormous amount of research that touts the health and disease prevention benefits of fiber, yet fiber levels in MRE's is well below current recommendations. Compared to the USDA's recommendations of 35 grams of fiber for a 3,600-calorie diet, the MRE's 20.75 grams of fiber pale in comparison.

The final area that prevents MRE's form being optimal is their sodium content. The nearly 6,000 mg of sodium contained in a days worth of MRE's is two and one-half times greater than what is recommended by the USDA and the AHA. Since, with the exception of ultra-endurance athletes, there is no evidence that any population groups need any more sodium than that which is recommended, there is really no reason why MRE sodium content is so high, other than taste. With the overwhelming evidence against high sodium diets, the Army would do well by reevaluating their stance on sodium.

In light of these conclusions, what will it take for the Army to achieve an optimal mix of

nutrients in their operational rations? First and foremost, the Army's Surgeon General's office must update their sixteen-year old directive to reflect the recent discoveries in the field of nutrition science. So much has been achieved by the nutrition science community in the past two decades that it simply cannot be ignored. The Army's R&D community must then translate this new directive into the right mix of nutrients in MRE's as discussed above, and they must, furthermore, require MRE contractors to provide this "new" mix in all MRE's. The R&D community may also find some relevance in exploring new ergogenic supplements, such as creatine monohydrate, and considering some recent, promising work being done in the new field of nutritional neuroscience on enhancing mental capabilities through nutrition.

Lastly, and perhaps most importantly, the Army's R&D community must quit trying so hard to have their MRE's mirror the sub-optimal Standard American Diet. After all, the Army is feeding warriors, not the "average" American. Warriors that the war-fighting CINC's should expect to provide optimal effort, for any operation, no matter how long in duration.

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